

Letters to the Editor.

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Earthworms Drowned in Puddles.

I HAVE long been familiar with the frequent occurrence of dead earthworms in surface "puddles" alongside gravel walks or roads, as described by Mr. Friend in NATURE of April 7, p. 172. I have supposed that they were "drowned" owing to the amount of free oxygen in the stagnant puddles being insufficient for their respiration. So far as I recollect, earthworms are not drowned (or, at any rate, not quickly) if they get into cool, clear, running water—which, presumably, contains a larger amount of dissolved free oxygen than does the rain-water accumulated about dead leaves and deoxidising or "reducing" mud. (See on this matter Darwin's "Vegetable Mould and Earthworms," pp. 13-16.) I confess that I do not know the facts as to the percentages of free oxygen and of oxygen-seizing matter in natural fresh-waters, or, indeed, in sea-water, in various circumstances; nor do I know the percentage of free oxygen necessary in water in order that it may—even for the brief period of an hour or two—support the life of an earthworm. I should be glad to know if these quantities have been determined. It is a common practice to kill earthworms for dissection by drowning them, but I think the water used is warmed. Many years ago I employed "normal saline solution" in the dissecting trough.

The respiration of the earthworm is carried out through the fine capillaries in the skin, which exposes a moist surface like that of a "lung" to the atmosphere. It is abnormal for it to be out of contact with atmospheric oxygen, even in the deepest burrows made by the worm. The abundant hæmoglobin in the blood of the earthworm must be kept charged with oxygen by its rapid passage through the extremely delicate capillaries of the skin, separated only from the atmosphere (as is the blood in the capillaries of a lung) by a moist membrane of extreme tenuity. How far this lung-like surface of the earthworm's body can suddenly take on the function of aquatic respiration is a question which some naturalist with a laboratory to work in should determine.

There are one or two striking facts in this connection which deserve consideration. First, there are numerous aquatic "water-breathing" Oligochaeta closely allied to the earthworm, but they are not capable of aerial respiration as an alternative. Some of them inhabit black, foul mud at the bottom of ponds, but, as a rule, they inhabit well-aerated waters. The commonest of them all, *Tubifex rivulorum*, is extremely sensitive to the lowering of the percentage of dissolved oxygen in the water in which it lives. A handful of some thousands of these worms, if placed (with a little river-mud) in a basin standing on a "sink" under a tap giving a small stream into the basin which overflows into the sink, will group themselves in a definite order, their heads downwards and their tails free and undulating in a constant rhythm, the blood-vessels in the tails thus carrying on active respiratory gas-exchange. They will flourish thus, grow, and reproduce (by eggs) for months! But if the flow of fresh, oxygen-holding water from the tap is shut off the rhythmic movement ceases, the worms separate and exhibit spiral contortions. They die in

the course of a few hours if the flow of water be not renewed, but when it is they at once recover and regroup themselves. I suppose (but have no further evidence) that they are as sensitive to the arrest of their normal aquatic respiration by loss of oxygen-carrying water as the earthworm is to the arrest of its normal aerial respiration by submersion.

On the other hand, it seems that one, at any rate, among our fresh-water worms is fairly tolerant of both the alternative conditions.

The "medicinal leech" (not to mention other leeches, such as *Trocheta viridis* and the numerous land-leeches) can live for many days out of water in "moist" surroundings, and also flourishes in submergence. The integument in the leech and the sub-jacent structures are firmer, and yet more elastic, than in the earthworm; and (as I showed nearly forty years ago) the branches of a very fine network of capillaries containing hæmoglobinous oxygen-seeking blood are actually distributed *between* the individual units of the single layer of cells which forms the epidermis. This brings them even closer to the atmospheric oxygen than in the earthworm. It seems that the leech shows the possibility of the same surface acting for either aquatic or aerial respiration. The exchange of the one respiratory medium for the other, without change in the respiratory organ, is exhibited by certain pulmonate Gasteropods allied to *Limnæus*, which in the Lake of Geneva inhabit deep water and take water into the lung-cavity. Conversely, the gill-chamber of some Gasteropods (*Cyclostoma*) becomes converted into a lung, as is also the case in various fishes liable to conditions of drought.

The presence, and also the absence, of hæmoglobin in the blood and in certain tissues of animals have an important relation to the special adjustment of various invertebrate animals to peculiar difficulties and requirements in regard to the supply of oxygen needful for respiration. I cannot in this letter even state the case adequately. For many years, by use of the microspectroscope, I have accumulated facts as to the distribution of hæmoglobin, but what is now especially needed is experiment and quantitative measurement to determine what is the significance of the presence of hæmoglobin in each case. To cite only a few cases, we ought to ascertain:—

(1) What *exactly* is the function of the hæmoglobin dissolved in the striped muscular tissue of vertebrates?

(2) What is its value in the muscular tissue of the lingual apparatus of all Gasteropods and Cephalopods, though otherwise absent from those animals?

(3) What is the explanation of the single exception to the rule as to glossophorous molluscs just stated, namely, the exceptional presence of abundant hæmoglobin dissolved in the rich red blood of the flat-coiled pond-snail (*Planorbis*), although it is absent from the blood of the common pond-snail (*Limnæus*) and of all other Gasteropods and Cephalopods? Again, what is the special value of hæmoglobin in the blood (in the form of red blood-corpuscles) of *Ceratisolen legumen*, whilst it is entirely absent from the common razor-fish (*Solenensis*) and from every tissue in practically all other Lamellibranchs excepting *Arca* and *Pectunculus*, which have (as has *Ceratisolen*) red hæmoglobinous blood-corpuscles like those of a frog?

(4) What is the physiological significance of the fact that all Hexapod insects of all kinds are totally devoid of hæmoglobin in any of their tissues, excepting the so-called "blood-worm" or larva of the Dipterous midge, *Chironomus*, in which the blood-fluid (not corpuscles) is richly coloured by it?

(5) Similarly, why of all the great tribe of Crustacea are the archaic *Apus* (which has blood as red as

that of a vertebrate) and a few water-fleas the only members possessing even a trace of hæmoglobin, excepting one marine fish-parasite (*Lernanthropus*)?

(6) The only common feature in the "conditions of life" or environment of these exceptional cases of the presence of hæmoglobin is that some of them, viz. the Planorbis snail, the larval Chironomus, and the crustacean Apus, live in stagnant fresh-water, even in black mud, where free oxygen is scarce owing to the decomposition of vegetable debris. But in what special way and to what extent is the hæmoglobin valuable to its possessors, seeing that other closely related species are associated with them and are devoid of hæmoglobin?

(7) One more case must be noted, namely, the very common presence of hæmoglobin in the blood-fluid of the Chætopod worms, both marine and fresh-water, whilst, nevertheless, it is absent from many. In some of these worms "red blood-corpuscles" replace the entire vascular system and its red fluid; they float in the coelomic fluid. In one case, that of the large and beautiful marine worm, Aphrodite (the "sea-mouse"), whilst hæmoglobin is absent from the blood, it is present in such quantity in the nervous tissue of the great nerve-cord as to give it a ruby-red colour. It also gives a pale pink colour to the great muscular pharynx. In what way does the sluggish Aphrodite benefit by having its nerve-cord saturated with the oxygen-seizing hæmoglobin? Similarly, some few of the remarkable Nemertine worms have hæmoglobin in the corpuscles which float in the fluid of certain vessels, and others have it only in the tissue of the nerve-cord and brain.

To conclude, we might, it seems to me, arrive at some better understanding of the general physiology of respiration in animals were the cases I have cited more accurately (I mean quantitatively) investigated; and were the striking facts also held in view, that no Protozoon, no Sponge, and no Coral or Polyp is known to develop "hæmoglobin," whilst in only one starfish and one Holothurian (recent additions to the list may have escaped my attention) has hæmoglobin been recorded, and that in the form of "red blood-corpuscles."

E. RAY LANKESTER.

44 Oakley Street, Chelsea, S.W.3, May 3.

A "New" Type of Tool of Mousterian Age.

The object of this letter is to describe briefly a hitherto unrecognised type of implement of Mousterian age and to ask readers of NATURE for any information they can give me as to its geographical distribution.

Considerable collections of flint—or, more correctly, chert—implements of Palæolithic types were made by myself in 1914, and by Mr. G. W. Murray, of the Survey of Egypt, in the following years. My own specimens are from the western desert, Mr. Murray's from sites discovered by himself in the eastern desert. Both series show a number of tortoise cores of Mousterian age—the age determined not only by type, but also the discovery by myself of a typical core in a hard-cemented gravel recognised by Dr. Hume as of Pleistocene age—which have been worked up to produce a type of tool which, so far as I can discover, has not been recognised previously. Before describing this form of implement I must point out that typically domed tortoise cores are not common in Egypt; most cores are flatter, presumably because the nodules from which they were made were oval rather than spherical, and are so trimmed as to have, roughly, the shape of a half of a somewhat

flattened pear, the notch indicating the point at which the core is struck being situated at the broad end of the pear.

Regarding the face of the core from which a Levallois flake has been struck as the upper surface, the "new" tool consists in the production at the narrow end of this surface of an upturned point or beak. In its simplest form this is produced by the meeting at the narrow end of the core of the two planes (or facets) bounding the flake-bed left by the removal of the Levallois flake, and of a facet constituting a third plane, joining these at an angle, produced by striking off a flake from near the point

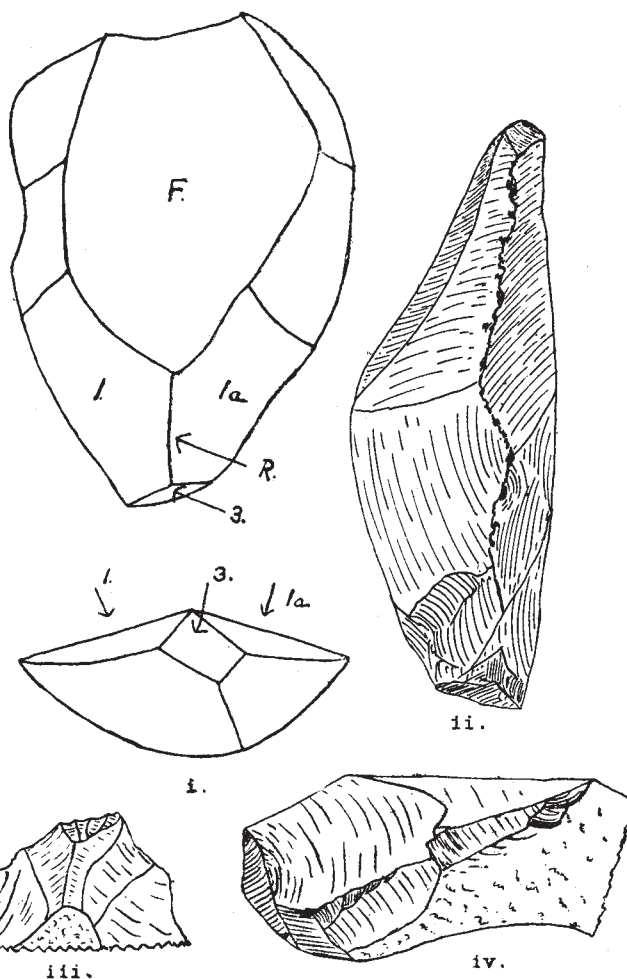


FIG. 1.

of the lower (convex) surface of the core. The diagram (Fig. 1, i.) will make this description clearer; it will be seen that the lower part of the scar-bed of the Levallois flake (F) is bounded by two narrow facets (1 and 1a) the intersection of which gives rise to a crest or ridge (R). This crest and its two bounding facets are terminated abruptly by the facet (3) produced by a blow struck on the convex surface of the stone.

Fig. 1, ii., is a somewhat diagrammatic rendering of the side view of an implement of the type described, and shows the heavy triangular point not unlike the beak of a chelonian, which is characteristic of the